

MORPHODYNAMICS OF COASTAL AREAS REPRESENTED IN THE NEW GEOMORPHOLOGIC MAP OF ITALY: DRAW THE LANDFORMS OF THE PAST TO OUTLINE THE FUTURE

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ABSTRACT: In the framework of the revision of Italian geomorphological legend (CARG Project) published in 1994 by the National Geological Service, the AIGeo-Working Group Coastal Morphodynamic (WGCM) dealt with the revision of the legend concerning the landforms of the coast. The aims of the work were the updating of the symbology on the basis of the post-1994 results in the geomorphological researches and creating a legend more vocated to the solution of the problems of applied geomorphology and more suitable to be managed in GIS environment.

The WGCM started from the critical analysis of the classifications of coastal landforms proposed during the last century and it continued through a scientific discussion on the work that the members of the group performed by means of 12 case studies in which a correlation between landforms, processes and, dynamics was made.

The geomorphological legend proposed by the WGCM has to be considered as a starting point and a work in progress. It remains, indeed, open so that new data can be added and updated as required. Besides, the WGCM tried to contribute to the morphodynamic classification of the coasts around the Mediterranean basin.

KEYWORDS: Coastal dynamics, coastal geomorphology, geomorphological mapping, Mediterranean coast

1. INTRODUCTION

The geomorphological map is the basic tool for the representation of landforms of earth topographic relief and, as such, is currently the document present in most of the activities of environmental planning carried out in Italy at the various institutional levels, from the national to the municipal one, with particular reference to the evaluation of geomorphological hazards and the mitigation of the associated risks.

The geomorphological mapping in Italy has reached

high levels of scientific value in the description and analysis of the landscape and in returning correct territorial data from the dimensional point of view, as well as providing the necessary geomorphological information useful for the applied purposes in different scientific sectors, such as hydraulics, forestry sciences, agronomy, environmental engineering, architecture, landscape ecology, etc.

Besides, thanks to the capability to represent the state of activity of landforms, and of associated processes of course, the geomorphological mapping is the

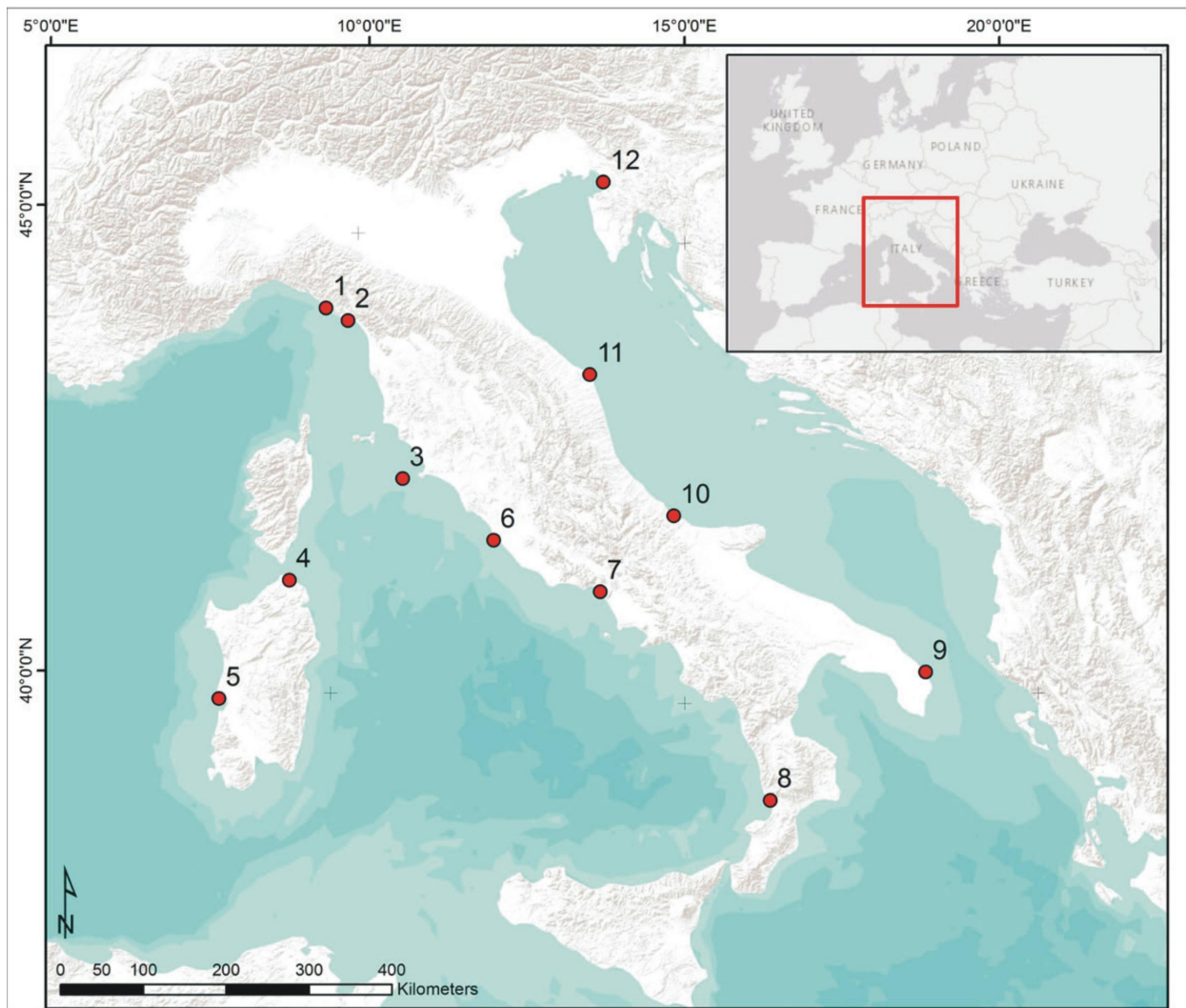


Fig. 1 - Case studies: 1) Bonassola- Levante rocky coast and embayed beach; 2) Tellaro rocky coast; 3) the Franco Promontory and the Campese Bay; 4) Isola dei Gabbiani Tombolo; 5) the coastal area of Torre San Giovanni - Capo San Marco; 6) the Tiber River Delta; 7) littoral of the Garigliano River Mouth; 8) the La Vota paralic system; 9) the Roca - Sant'Andrea coast; 10) the Northern sector of the Molise Coast; 11) the Northern coastal sector of the Mt. Conero Promontory; 12) the rocky coasts of the Gulf of Trieste (from Mastronuzzi et al., 2017).

primary tool to provide a dynamic view of the landscape.

The legend of the Geomorphological Map of Italy (CARG Project) published in 1994 by the National Geological Service (Brancaccio et al., 1994) represented the first document that summarized the different approaches to the representation of landforms that were developed in Italy by different schools, since the sixties of the last century.

In fact, the current system of Italian geomorphological mapping has its origin from the works of Authors such as Castiglioni (1964) and Panizza (1966) who have also worked in synergy with international groups and from the experience shared through workshops of informal working groups constituted by Italian geomorphologists (GSUEG, 1978; GRG, 1982; GNGFG, 1986; 1987; 1993; 1995).

Since 2015, the Italian geomorphologists commu-

nity has started, as part of the works of the Italian Association of Physical Geography and Geomorphology (AIGeo), the revision of the 1994' legend, thanks to the work of the Working Groups (WGs) born within the Association.

The WG Coastal Morphodynamic (WGCM), established by AIGeo in 2013, dealt with the revision of the legend concerning the landforms of the coast, dealing with the landforms of wave-climate and eolian origin, these latter having, in the morphoclimatic system that characterizes the Italian peninsula, the best expressions in correspondence of the morphosedimentary dune-beach systems.

The aims of the WGCM were: 1) to implement and update the symbology by introducing the results of the last 25 years of geomorphological research, 2) creating a legend and then a geomorphological map, with a

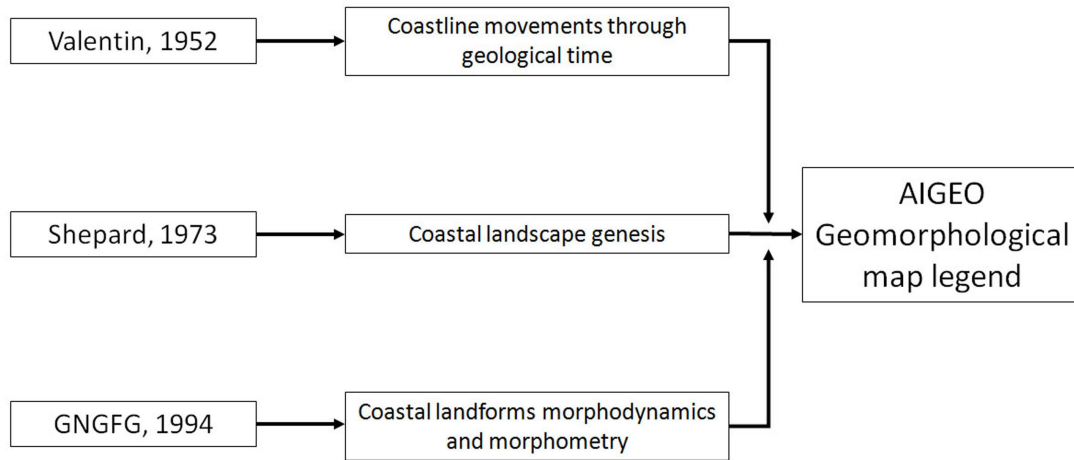


Fig. 2 - Theoretical flow-chart explaining the construction of the new geomorphological legend of the Italian coast. The legend has been built starting from the analysis of the coastal landscape recognising the landform genesis, while considering their evolution and present dynamics in relation to the sea-level history and evolutionary trends of shore/coast-line (from Mastronuzzi et al., 2017).

greater vocation, compared to the current one, towards the solution of the problems of applied geomorphology, such as the analysis of the geomorphological hazards and risks and the exploitation of the geomorphological heritage, and 3) to think to symbols that can be more suitable, than the current one, for the creation of a cartographic system that is even more manageable through the use of GIS tools.

2. THE NEW GEOMORPHOLOGIC LEGEND OF ITALIAN COAST

In the framework of the activities for the new geomorphological legend of the Italian coast, the WGCM, other than the guide to geomorphological mapping of Italy at the scale 1:50,000 (Brancaccio et al., 1994), considered besides the results of the other important study concerning geomorphological mapping of the coasts of Italy, i.e.: the Atlas of Italian Beaches (Atlante delle Spiagge Italiane; Aa.Vv., 1997) based on the results of the “Conservazione del suolo”, “Dinamica dei litorali” sub-project.

The legend here proposed collects recent research advancements carried out by the community of Italian coastal geomorphologists as well as the results of an articulated scientific discussion developed within the WGCM based on the work that the researches performed by means of 12 case studies (fig. 1) in which a correlation between landforms, wave-climate data, and dynamics is presented. The aim has been to summarise the most recent results in mapping the coastal landforms within the context of a long cultural process, involving the Italian scientific community.

The realization of the geomorphological legend was, indeed, the result of a theoretical approach, based also on the critical analysis of the classifications proposed during the last century (see Finkl, 2004 and references therein), and of a coastal landscape analysis, recognising the landform genesis at a regional scale,

while considering their evolution and present dynamics (Shepard, 1973) in relation to the sea-level history and evolutionary trends of shore/coast line (Valentin, 1952).

The study focuses, indeed, on the entire coastal perimeter of Italy, including different geodynamic areas, ranging from those characterised by high uplift rates to those stable or subsiding, in the Mediterranean climate region, considered as a single morphoclimatic zone. The latter aspect considers the sea energy as “homogenous”, being only affected by lithology and exposure/fetch of each area. The role of 1) inherited landforms (i.e. hillslope or karst cave in submerged areas), 2) volcanic processes, which can characterise a coastal area, 3) continental processes in coastal areas (i.e.: landslides triggered by non-marine processes) and, 4) anthropogenic factors has been also considered. In order to address these issues, the primary task of this study has been to create a classification of coastal landforms which, compared to any previous descriptive/genetic approaches, will be quantitative and dynamic in relation to processes.

The coastal landforms are mainly classified in function of the genetic mechanism still active in their dynamics, while also taking into consideration inheritance, spatial and temporal scales, as well as potential changes in the architecture of the coastal landscape (Mastronuzzi et al., 2017).

The proposed legend has been subdivided into different thematic layers and at different map scales, reporting morphogenetic, morphometric, and morphodynamic data, and thereby facilitating their input into a Geographical Information System (GIS). In this way, data reported on geomorphological map can be used for several purposes by different stakeholders, from researchers to land-use planners.

With the adopted approach, the required geomorphological analysis of coastal landscapes has to be integrated using qualitative and quantitative data on landform genesis and dynamics. At first, it appeared

a

Continental Shelf											
MP001		Shelf breaks	MT017		Erosive notch	MT036		$\phi > 2$ mm SB	MT056		Lagoon channel
MP002		Retreating	MT018		Seacave	MT037		$0.062 < \phi < 2$ mm SB	MT057		Tidal channel
MP003		Prograding	MT019		Blowhole	MT038		$\phi < 0.062$ mm SB	MT058		Lagoon mouth
MP004		Submarine canyon	MT020		Stack	MT039		Sandy-gravel SB	MT059		Tidal flat
MP005		Edge of canyon	MT021		Arch	MT040		Clay-gravel SB	MT060		Saltmarsh
MP006		Submarine valley	MT022		Cliff	MT041		Gravelly-sandy SB	MT061		Mudflat
General			MT023		Boulder	MT042		Clay-sandy SB	MT062		Hollow
MT007		Shoreline	MT024		Marine erosion scarp	MT043		Gravelly-clay SB	MT063		Open river mouth
MT008		Retreating	MT025		Simple coastal slope	MT044		Sandy-clay SB	MT064		Temporary river mouth
MT009		Prograding	MT026		Complex coastal slope	MT045		Sandy pocket beach	MT065		Wandering river mouth
MT010		Stable	MP027		Wave cut platform	MT046		Sandy-pebble pocket beach	MT066		Distributary channel
MT011		Rocky coastline	MP028		Surf bench	MT047		Pebble pocket beach	MT067		Cuspate delta
Rock Coast			MP029		Wheathering platform	MT048		Cusps	MT068		Lobate delta
MT012		Erosional pool > 1 m	MP030		Bioactivity platform	MT049		Beach rock	MT069		Fingering delta
MT013		Potholes > 1 m	Sedimentary and Transition Coasts			MT050		Littoral barrier	MT070		Tidal delta
MT014		Solution pool > 1 m	MT031		Pebble beach at foot cliff	MT051		Tombolo	MT071		Estuary
MT015		Tidal notch	MT032		Sandy beach at foot cliff	MT052		Pond, wetland, marsh	MT072		Delta front
MT016		Abrasion notch	MT033		Sandy EB	MT053		Peat deposit	MT073		Prograding delta front
			MT034		Sandy-pebble EB	MT054		Lagoon	MT074		Retreating delta front
			MT035		Pebble EB	MT055		Ancient lagoon border	MT075		Submerged fan

b

MT076		Mega ripple	Tsunami/Seastorm Deposit			Spring			EL016		Vegetated dune crest
MT077		Ripplemarks	MT094		Isolated boulders	MT111		Gas	EL017		Stable dune crest
MT078		Single submerged bar	MT095		Boulder accumulation	MT112		Fresh water	EL018		Sheet loess area
MT079		Submerged bar	MT096		Boulder field	Eolian Landform			EL019		Transgressive moving dune
MT080		Runnel axis	MT097		Washover sands	EL001		Deflation surface	EL020		Transgressive vegetated dune
MT081		Rip current	MT098		Inland penetration	EL002		Blow out	EL021		Transgressive urbanized dune
MT082		Washover fan	Elements due to Biological Activity			EL003		Deflation furrow	EL022		Transgressive stabilized dunes
MT083		Backwash fan	MP099		Seagrass meadow	EL004		Not eroding ED	EL023		Foredune plains
MT084		Beach ridge	MP100		Sparse seagrass meadow	EL005		Eroding ED	NOTE		
Marine Terraces: Landforms and Granulometries			MP101		Algae formation	EL006		Not eroding PDR	EB = Emerged Beach		
MT085		Abrasion terraces	MP102		Sparse algae formation	EL007		Eroding PDR	SB = Submerged Beach		
MT086		Inner margin	MP103		Rim	EL008		Not eroding SDR	PDR = Primary Dune Ridge		
MT087		Outer margin	MP104		Dead matte	EL009		Eroding SDR	SDR = Secondary Dune Ridge		
MT088		Silt	MP105		Coralligenous	EL010		Not eroding TDR	TDR = Tertiary Dune Ridge		
MT089		Sand	MP106		Tubipore colonies	EL011		Eroding TDR	ADR = Antropized Dune Ridge		
MT090		Cemented sand	MP107		Intramatt deposit	EL012		Not eroding ADR	MT = Marine Transitional Zone		
MT091		Gravel	MP108		Biogavel deposit	EL013		Eroding ADR	MP = Marine Platform Zone		
MT092		Cemented gravel	MP109		Biosand deposit	EL014		Lithified dune	EL = Eolian Landform		
MT093		Cemented blocks	MP110		Banquette	EL015		Wandering dune crest	ED = Embryonal Dune		

Fig. 3a,b - The new geomorphological legend of the Italian coast (from Mastronuzzi et al., 2017).

useful and necessary to maintain a purely descriptive approach of the coastal landforms and landscapes.

However, from the perspective of the actual "end users", it then became clearly evident that it would be much more useful to provide genetic and dynamic data. For this reason, in the legend, the description and the genesis of inherited landforms along with the description of their current dynamism have been included.

Information about inheritance and dynamism is especially useful in scenarios where a landform may not correlate to modern dynamic environment. Landforms occurring in rocky coastal environment, such as sea caves and karst caves, both emerged and submerged, can be found in the same place even if their genesis results from two different morphogenetic systems and processes. For example, a marine cave could be the evolution of a karstic cave shaped in fully continental condition subsequently modified by marine erosive/depositional or biochemical processes as the sea-level reached it.

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